U.S. Department
of Transportation
Research and Special
Programs Administration .

Intelligent Transportation Systems Professional Capacity Building Program Needs Assessment

A Review and Synthesis of Thirteen Studies

September 1997

Review Draft

Prepared for:

U.S. Department of Transportation
ITS Professional Capacity Building Program
Washington, DC

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Preface

Intelligent Transportation Systems (ITS) are designed to enhance the safety and efficiency of surface transportation systems by implementing advanced electronic sensors, navigation devices, communications, and information technologies. The General Accounting Office cited[1] "a lack of technical knowledge and expertise among the state and local officials who will deploy the systems" as a significant obstacle confronting widespread ITS deployment.

The ITS Professional Capacity Building Program (PCB) was established to ensure that current transportation professionals have the knowledge, skills, and abilities to effectively deploy ITS. The program has adopted a multi-faceted approach to identify gaps in the knowledge, skills and abilities which serve as impediments to ITS deployment. The overall approach draws upon the review and synthesis of prior ITS training needs studies; interviews with Federal, state, and local ITS field staff; white papers on professional society / association perspectives; and commentary from PCB course participants. In addition, PCB needs assessment is closely coordinated with a comprehensive, agency-wide training needs assessment effort now being conducted by FHWA.

This report, ITS Professional Capacity Building: A Review and Synthesis of Thirteen Studies, serves as a companion report to ITS Professional Capacity Building: Field Interviews. This report summarizes what other organizations concerned about ITS staffing and training have learned and identifies knowledge gaps that need to be addressed. The Field Interview report identifies the staffing and training needs of agencies and organizations actively involved in deploying ITS. The information in these studies provide a representational, rather than a scientific, sampling of ITS staffing and training issues. Combined, these studies provide a basis for targeting training courses and curricula to address ITS professional capacity building needs.

[1] ***Urban Transportation: Challenges to Widespread Deployment of Intelligent Transportation Systems*** (Letter Report, 02/27/97, GAO/RCED-97-74).

Acknowledgment

The U.S. Department of Transportation's (USDOT) Volpe National Transportation Systems Center provides support to the US DOT's Intelligent Transportation Systems (ITS) Program. This report was developed for the US DOT's ITS Professional Capacity Building Program under the direction of Thomas F. Humphrey, coordinator of the ITS Professional Capacity Building program. The primary researcher and author of this report is Terrence F. Smith of EG&G Dynatrend. Valuable assistance was provided by other members of the Volpe Center Team including John O'Donnell, Gary Bitter, Sylvia Harris, Suzanne Sloan, and Cynthia Maloney.

Executive Summary

The need to develop a "new breed" of transportation professionals to successfully deploy, operate, and maintain intelligent transportation systems (ITS) has been the subject of studies, conferences, and workshops, and strategic and program plans, since 1992. These efforts consistently show that training programs are necessary to meet ITS staffing needs.

Thirteen studies were reviewed for this synthesis report. These studies have been categorized into three general areas, Staffing Studies, Training Studies, and Staffing and Training Needs Assessments. These studies, which are summarized in three Appendices defined by report category, establish a starting point for a comprehensive staffing and training needs assessment. All of the reports found that ITS requires introducing new knowledge, skills, and abilities into the transportation profession and that full deployment will require new staff and retraining existing staff

The studies identify some staffing issues, skills, and training needs, and some sources of training, barriers to training, and concerns about the ability of organizations to staff for full deployment. They also have some limitations. The studies are usually either general, cataloging every skill required for ITS deployment, or specific, addressing one facet of ITS, a specific organization, a limited geographic area, or staff at a narrow organizational level. Many studies have been done by agencies and organizations interested in traffic engineering, resulting in an emphasis in that profession's training needs. This leaves a gap in knowledge about the ITS staffing and training needs of other transportation professionals and organizations. For example, only a few of the studies include information from transit agencies and local government.

This review and synthesis identifies some actions that are necessary to address ITS staffing needs. The Field Interview report will supplement this information, as will other ongoing ITS research efforts. The next steps toward a comprehensive assessment of ITS staffing and training needs will build on the information summarized in this report about what was learned from the thirteen studies and the knowledge gaps found in analyzing these studies. The next steps are to identify skills across organizations involved in ITS deployment, rank training priorities, and identify additional knowledge gaps. This will form the basis for development of ITS courses, curricula, and training.

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Introduction

Full deployment of Intelligent Transportation Systems (ITS) on a nationwide basis requires development of staff with the knowledge, skills, and abilities to plan, design, build, operate, maintain, and manage ITS projects. Developing this staff requires development of ITS training. A starting point for identifying ITS staffing and training needs is the ITS deployment sequence. In general, the deployment sequence includes:

- **General Awareness** of ITS that establishes the foundation for understanding the need for ITS, the scope of ITS, and the roles of the agencies involved in ITS deployment;
- **Planning for** ITS which encompasses the notion of establishing a regional framework and develops an understanding of conformance to the National Architecture;
- **Designing for ITS** with an eye towards interoperability and intermodalism;
- **Procuring for ITS** including innovative financing methods;
- **Installing ITS** which Includes the role of contracting organizations; and
- **Operating and Managing** the ITS system once deployed.

Analysis of ITS training and staffing studies published since 1992 provide a starting point for identifying current and future ITS staffing and training needs. These can be roughly categorized as staffing studies, training studies, and assessments of staffing and training needs. These studies, which for the most part identify issues raised by individuals and organizations involved in some aspect of ITS deployment, provide important information about the staffing and training concerns of these agencies. The thirteen studies reviewed for this report are summarized in three appendices.

This report provides a synthesis of studies on ITS training and staffing needs and identifies work that still needs to be done. While none of these reports use the deployment sequence as a model, the sequence is still a useful tool for summarizing and analyzing information from these reports. The studies are also limited because most were developed with a limited focus and lack the specificity needed to develop a training and education program. In addition, the needs assessment approaches used in these studies were either too general or not comprehensive enough to address the core training needs of ITS deployment.

This report contains four sections. The first section categorizes and broadly summarizes the studies reviewed and the approaches authors used to gather and analyze information. The second section summarizes findings and includes summaries of staffing and training findings, a synthesis of skills identified and training needed identified in the studies reviewed, and a summary of other issues affecting staffing and training. This section summarizes information from the studies using a structure defined by the ITS deployment sequence. The third section identifies the current gaps in knowledge. Three major areas of shortcomings have been identified, which include identification of core knowledge, skills, and abilities, development of curricula, courses, and programs, and delivery of courses and programs with educationally effective media. The fourth section presents a general framework for a comprehensive ITS staffing and training needs assessment. The report

concludes with a general identification of what needs to be done to address ITS staffing needs in the next five years, including the need to continue to gather information for a comprehensive ITS needs assessment.

I. Summary of Existing Studies

Studies completed to date fall into three broad categories; staffing studies, training studies, and staffing and training needs assessments. Staffing studies identify current and future staffing needs either for national deployment of ITS or to address ITS issues within a specific agency or profession. Training studies identify skills needed to address ITS issues and the type of training required to transfer these skills to current or new staff. Training and staffing needs assessments either define an approach to identifying staffing needs, training needs, and sources of training or specifically analyze these three factors. Studies are grouped below.

Staffing Studies

- Institute of Transportation Engineers (ITE), *White Papers: Operating and Maintaining Advance Traffic Management Systems (ATMS) Centers,* 1996.
- Kraft, Walter H., *Conference Summary and Conclusions, ITE National Conference on Operating and Maintaining ATMS Centers,* 1996.
- McComb, Dwight E. and Martin J. Monahan, *Federal Highway Administration ITS Field Technical Expertise; Workshop Summary Report,* 1994.
- Robinson, Carlton *C., Traffic Operations Manpower; (A Scoping Study of Education Needs and Responses, 1994.*
- Urban Institute, *IVHS Staffing and Education Needs,* 1993.

Training Studies

- California Advanced Transportation Training Alliance, *The View Ahead,* 1996.
- ITE, *Urban Traffic Engineering Issues and Answers: Urban Traffic Engineering Education and Training Needs, Final Report,* Undated.
- ITS America and US DOT, FHWA, *ITS Education and Training; Strategic Planning Workshop Proceedings, 1995.*
- ITS America and US DOT, FHWA, *Strategic* Plan *for ITS Education and Training (Draft),* 1996.
- US DOT, Office of Traffic Management and ITS Training Team, *DOT ITS Professional Capacity Building Assessment, 1995.*

Staffing: and Training: Needs Assessments

- *I-95* Corridor Coalition, *Project I I Training and Technology Exchange Final Report, 1996.*
- *SAIC/JHK, Technical Memorandum on ITS Training Needs,* 1996.
- Virginia Tech, *Virginia Tech Model for Professional Capacity Building: Comprehensive Needs Analysis & Functional Specialization,* Undated. *(NB:* This study suggests a method for completing a comprehensive staffing and training needs assessment.)

A. Overview of Studies Reviewed

Developing a training strategy requires an understanding of knowledge, skills, and abilities required at each stage of a process and at each level of participation in the process. For ITS, this requires understanding training needs along the deployment process and through organizations, from senior management, to maintenance and support staff. A first step in needs assessment is gathering information.

Several studies sponsored by the Federal Highway Administration (FHWA) and other agencies have had broad mandates to identify ITS staffing and training needs. For example, a study done by the Urban Institute (Urban Institute Study) for the FHWA analyzed the labor market to determine whether individuals with training and skills, defined in broad terms, would be available to develop, implement, and operate ITS. Several other studies that were broad in nature were undertaken to identify all the potential skills that ITS deployment may require. This was typically done by asking transportation professionals, academics, and others to list all the skills they thought were important for ITS.

Most studies looked at training needs narrowly. One report looked at the training needs of traffic engineers who may have ITS responsibilities. Another looked at the needs of a staff in a single organization with limited ITS responsibilities. Both the broad and narrow studies provide information that is useful to begin the process of identifying ITS training needs.

Studies done to date have either gathered general information across a broad range of transportation professionals or specific information from a narrow range of professionals. Despite these limitations, some studies have taken a first step towards matching skills with specific training. A study sponsored by the I-95 Coalition reviewed courses currently available that may be applicable to ITS. In addition, several studies considered methods of training, including formal degree programs, in-service workshops, on the job training, and self directed training.

B. Methods Used to Identify Needs

Studies have relied on several methods to collect information on ITS staffing and training needs. They have usually included a review of other studies on the same and related topics. Additional information has been gathered through several methods including surveys of individuals and organizations that have, or may have, an interest in some facet of ITS.

Some surveys were done formally, others were less formal, simply asking interested parties to summarize skills they considered important for ITS. The range of surveys used and organizations surveyed vary. One problem with all the surveys was that they were directed to a very limited population, such as staff from a specific agency or individuals who perform specific ITS related functions. Additional methods of gathering information included interviews, focus groups, workshops, and other supplemental information.

Two studies are important for both their approach and their findings. The first is the Urban Institute Study, published in 1993. This was the first study to review the labor market for personnel with skills likely to be required for ITS. It also considers training available in ITS related skills. This study provides a detailed analysis of the labor market for personnel with the skills envisioned as needed for ITS, then called Intelligent Vehicle Highway Systems (IVHS). This information was refined through interviews and surveys of organizations involved in ITS. This study is referenced in most of the other studies reviewed.

The second study is the I-95 Study completed in 1996. It reports information from staff actively involved in ITS activities along the I-95 corridor and from training organizations. It provides an analysis of the demand for training and supply of training resources. The approach taken by this study is a comprehensive assessment of ITS training needs. This study builds on other research, but is unique because many organizations responding to the survey are actively involved in deploying ITS. This study includes results from a survey of transportation agencies along the I-95 corridor.

Studies that were done in the period between these two studies rely on a variety of knowledge bases. The Urban Institute and I-95 studies are useful bookends because information provided in the Urban Institute Study was developed for the first time and the I-95 Study provides a model for a comprehensive analysis of ITS training needs. Other studies started by identifying existing training in skills required for ITS with surveys and discussions centered on whether existing training meets the needs of ITS and how training can be adapted to incorporate skills required for ITS. These studies focused on specific aspects of ITS or specific organizations involved in ITS. The result was a focus on specific current needs rather than identifying the long-term range of skills and training ITS will require.

II. Synthesis of Findings

There is general agreement that ITS requires bringing new knowledge, skills, and abilities into the transportation profession and that full deployment will require new staff and retraining existing staff Prior studies have identified some staffing issues, skills, and training needs. They also identify sources of training, barriers to training, and concerns about the ability of organizations to staff for full deployment.

Key finding fall into three major areas; general findings, staffing findings, and training findings. The major general finding is that full ITS implementation requires addressing three major issues; awareness, education, and training. There is also general agreement that identifying who needs training requires the identification of organizations that will be responsible for deploying ITS. The next step is to determine the level and type of training needed. Once training needs are established, it is possible to analyze existing resources that may be used to develop training courses. The last step is to identify the specific knowledge, skills, and abilities that staff involved in ITS require.

This section summarizes what has been learned from these studies about requisite skills needed for ITS, training needed for ITS deployment, and other issues related to ITS staffing and training. It has four parts. The first part summarizes key staffing findings, these being the most important things learned directly related to ITS needs. The second part summarizes major training findings, these being the most important things learned directly related to identifying skills and training needs. The third part identifies training needs by intensity level and functions by synthesizing information from the studies. The last part identifies other issues that will affect ITS training and staffing.

A. Staffing Issues

Staffing issues include availability of individuals with required training and the ability to train current and future staff. Studies also identified staffing issues not specifically relevant to training activities. These included issues related to salary, benefits, culture, and career tracks in agencies that are most likely to be involved in ITS. A significant issue may be the ability of agencies to hire staff The positions required for ITS may not currently exist, which would require developing new position descriptions and adding staff. Many government agencies have established reducing staff as a goal. This may be a major issue in some areas considering ITS deployment.

The Urban Institute Study highlights this concern by noting staffing constraints faced by government agencies. They broaden this concern to include comments on the availability of government staff to do nontechnical functions such as addressing institutional, economic, social, and environmental issues as a staffing issue. An additional concern is the availability and training of operations and maintenance personnel and support given for these functions. The Urban Institute Study found a lack of personnel with required scientific and technical skills in the transportation labor market. However, it suggests that this need could be met by retraining personnel from the defense sector.

Several studies note that ITS skills are learned on-the-job. For example, most traffic control center personnel learn how to do their job by doing it after a brief period of in-house training. This is necessary, according to the studies, because each center is unique. A concern about on-the-job training expressed in several studies was the availability of trained staff to provide this training.

Studies note that the current level of knowledge, while sufficient to support current ITS activities, is not sufficient for significant enhancement of these activities. Nationwide deployment of ITS will create a demand for more technical staff than is currently available. Training and retraining are necessary to have sufficient staff for full deployment of ITS. Several studies note that training in non-technical skills is as important as training in technical areas.

A long-term staffing issue identified in several studies is support for training. Agency staff are concerned that elected officials and senior managers will not provide long-term support to a training program. One report recommends developing a strategy to show importance of ITS staff training to senior management and elected officials. This strategy should make the point that training should be available through a continuous education program.

To summarize, the major staffing issues identified in the studies reviewed are:

- Current availability of technical staff is insufficient to support full deployment of ITS.
- A comprehensive, continuous, long-term training program can address this staffing need.
- A strategy is needed to ensure that elected officials and senior management support training over the long-term.

B. Training Issues

The training issues identified in prior studies provide a guide for both identifying specific training needs and for developing an approach to delivering training. Studies found that staff from different organizations and at different levels have different needs. This requires looking at each ITS skill in terms of who is responsible for what work at what point along the deployment sequence and at what organization level.

The survey results reported in the I-95 Study categorize training in relation to six major functional categories: Planning, Design, Construction, Operations, Maintenance, and Management. These categories can be associated with the ITS deployment sequence, and provide a starting point for this analysis. The study also surveyed organizations that are potential training resources. The responses by those requiring staff training and those available to provide training establishes a starting pont for evaluating training demand and supply.

Several studies were directed at specific specialties within the transportation profession. For example, one study recommends development of new media for education and training in traffic engineering. Another recommends development of a core curriculum from the proposed Traffic Operation Core Curriculum and require that courses funded through NHI grants be patterned after this curriculum. Studies also identify staffing, funding, operational, and other issues related to all aspects of operating a Transportation Management Center (TMC) and the need for implementation of a traffic engineering certification program.

Other studies target specific organizations. One study recommends that training be developed to enhance ITS knowledge of FHWA and FTA field staff. Another identifies the FHWA as a source of high level technical expertise in ITS. This study suggests that FHWA develop an in-house inventory of technical expertise and support enhancement of State DOT technical expertise. One study suggests that DOT investigate development of an ITS Education and Training Institute. Yet another study recommends that the federal government continue to support Technology Transfer Centers, University Transportation Centers, and Research Centers of Excellence, and coordinate ITS, and other, activities with these organizations and professional and industry organizations.

Studies found that agencies are looking at how they currently provide training and how training should be delivered. Agencies implementing one or more ITS component, an advanced traffic management system for example, use on the job training by experienced staff to train new staff. A

concern is that, once ITS is fully deployed, staff resources may not be sufficient to continue to provide on the job training.

ITS will bring staff from different organizations together to address transportation issues. It will also bring people with different skills together. A method to maximize both staffcapabilities and training is to cross train staff involved in traffic management center deployments.

Overall the studies report that agencies are aware of some, but not, existing training resources. Several studies have catalogued sources of training, but no critical analysis of this training has been done. Potential users of training programs note that time and budget constrain agencies from providing training, as do institutional issues.

In summary, the major training needs are:

- Training needs to be developed that addresses the skills needed at different staff levels within organizations and for different functions along the deployment sequence.
- The models for training identified in studies and should be considered when developing new courses and curricula.
- Resources need to be made available to allow agencies to continue to provide on-the-job training to ITS staff.

C. Training Needs by Function and Level

Studies identified specific training needs, often linked to specific ITS components, the specific needs of an agency or a region, or a combination of both. The following tables summarize what was learned about training needs and identifies some gaps in this knowledge. The tables provide information about the level of interest in training for different ITS components and skills across six functional area. These tables use the I-95 study as a model for synthesizing this information. (The I-95 study is summarized in appendix C.)

The information provided in the following tables is representative of ITS training and staffing needs, but is not based on a scientific analysis of these needs. The first table groups skills by ITS component, the second by enabling technologies, and the third by institutional issues. The final three tables identify skills needed for ITS planning, design and construction, and operation and management. For an ITS function or skills to appear on a table, it must have been identified in at least one of the thirteen studies. A description of how the tables are designed follows.

Column 1 Level of Interest

Several studies report survey information on the level of interest in training in ITS skills. This can be inferred from other studies by noting how often training in a skill is identified in reports. The key to this column is:

H High level of interest in training in this skill.
M Moderate level of interest in training in this skill.
L Low level of interest in training in this skill.
NR No Response. This is only reported when the information was provided by a survey and survey respondents did not respond to questions about the skill.

Column 2 Table Title

The second column of every table provides the title of the table and, in five of the six tables, two levels of information. The first level categorizes a general ITS component or skill, such as APTS or Computers. The second level identifies specific skills, such as Transit Vehicle Tracking or Hardware. Planning, Table 4, provides information on components and skills under the single category of planning.

Columns 3 to 8 Planning. Design. Construction. Operations. and Management

The I-95 Study serves as a model for the information summarized in the following tables. That study defined ITS skills by specific functions, these functions being Planning, Design, Construction, Operations, and Maintenance. The authors of the I-95 study surveyed transportation professionals, educators, and others to identify what the interest was in training in different ITS skills and the interest in training in those skills to address these six functions. This is useful for these summaries because these functions closely follow the ITS deployment sequence, summarized in the introduction, which serves as a useful model for a comprehensive ITS training needs assessment.

An X in a box indicates that one or more report has specifically identified need for training in a specific skill to address a specific function. For example, referring to Table 1, ITS Components, APTS Multimodal coordination. Each function is marked with an X, indicating that one or more study reported a need for training in this skill at each function.

A blank box usually indicates that information in reports is not sufficient to determine training needs in the functional area. Referring again to Table 1 - ITS Components. Under APTS, Transit vehicle tracking, all of the functions are blank. This indicates that more information is needed to determine what training, if any, is needed in these functions for this skill.

Table 1 - ITS Components

Table 1, on the next page, summarizes information from several reports on training needs related to component systems that would be part of an integrated ITS deployment. Several reports identify these specific component systems as defining the staffing and training needs of agencies and organizations deploying ITS.

Level of Interest	ITS Component	Planning	Design	Construction	Operations	Maintenance	Management
	APTS						
M	Multi-modal coordination	X	X	X	X		X
L	Transit vehicle tracking						
	ATIS						
H	Route guidance	X	X		X	X	X
H	Variable Message Signs (VMS)	X	X	X	X	X	X
M	Broadcast-based	X	X		X	X	X
M	Kiosks	X	X	X	X	X	
M	Traveler advisory telephone	X	X		X	X	
L	In-vehicle				X		
NR	Highway Advisory Radio (HAR)						
	ATMS						
H	Incident detection & verification	X	X	X	X	X	X
H	Incident Response	X	X	X	X	X	X
H	Probe Technologies						X
H	Violation enforcement systems	X	X	X	X	X	X
M	ATMS Control Center Operation						
M	AVL/AVI	X			X	X	X
M	CCTV	X	X	X	X	X	X
M	Freeway Control	X	X	X	X	X	X
M	HOV Lane Control	X	X	X	X	X	X
M	Incident Management						
M	Ramp metering				X	X	X
M	Sensor Technologies	X	X	X	X	X	X
M	System Optimal Routing	X	X	X	X	X	X
M	Traffic Control & Surveillance						
M	Traffic Signal Control				X	X	X
M	Video Imaging Processing	X	X	X	X	X	X
L	Control Center Operations						
L	Electronic Toll and Traffic Management (ETTM)						
L	Transportation Management Center	X					
	CVO						
H	Electronic clearance		X		X	X	
H	HAZMAT management	X		X	X	X	X
H	Weigh-in-motion	X	X	X	X	X	
M	Roadside CVO safety		X	X	X	X	
L	Fleet administration						
L	Freight administration						

Table 1 – ITS Component

Note that two ITS components, Rural ITS and Advanced Vehicle Control and Safety Systems (AVCS), do not appear on Table 1. Information on these components is not provided on any of the tables because no report provided sufficient information to make any assessment of training needs in these ITS components. Of the components where some information is provided, the least information is provided about Advanced Public Transportation Systems (APTS). Only two components of an APTS system are identified. Very few studies have gathered information from public transit agencies. A significant amount of information is provided about the other three component systems. More is known about these systems because some of these systems have been deployed and because several studies specifically examined these component systems.

Table 2 - Enabling Technologies

The following table, Table 2, summarizes information from several reports about enabling technologies that will be required for ITS deployment. Information provided about these technologies covers a broad range of staffing and training needs. For example, some studies identify the need for computer training, without defining whether there is a need for hardware or software training, for specialized training in specific computer systems, or whether staff will require a general understanding of computers. Some of these gaps are tilled by other studies.

Level of Interest	Enabling Technologies	Planning	Design	Construction	Operations	Maintenance	Management
	Communications						
H	Communications						
H	NTCIP	X	X		X	X	X
H	Wire	X	X	X	X	X	X
H	Wireless	X	X	X	X	X	X
M	IEN	X			X	X	X
	Computers						
H	Hardware	X	X	X	X	X	X
H	Software	X	X	X	X	X	X
M	Component Selection						
M	Computer Systems/ADP/Software/Hardware						
M	Traffic Modeling Software						
L	Computer Selection						
	Other						
L	Navigation						

Table 2 – Enabling Technologies

Table 3 - Institutional Issues

Table 3 summarizes information from several reports that identify training needed to address a variety of issues that have been combined under the title Institutional Issues. These range from ITS awareness and marketing to training needed to address legal and procurement issues unique to ITS. Some of these skills have multiple facets. For example, legal issues range from those related to contracting with partners to develop the system to liability issues that may arise after a system is fully deployed.

Level of Interest	Insitutional Issues	Planning	Design	Construction	Operations	Maintenance	Management
	Awareness						
H	Marketing/Market Evaluation						
H	Overview	X					
M	Awareness	X	X	X	X	X	X
M	Technologies for different levels of personnel	X	X	X	X	X	X
M	User Services						
L	Information Dissemination Techniques						
L	ITS Overall/Integrated Training						
L	ITS Technical Issues						
L	ITS Technologies						
L	Successs and Benefits						
L	Traveler Information						
L	User Acceptance						
	Funding						
M	Funding/Financing						
L	Federal Aid Process						
	Safety & Security						
M	Safety						
L	Security						
	Other						
H	Legal Issues (Partnerhips, Liability, etc.)						
M	Procurement		X				

Table 3 - Institutional Issues

The next three tables address training needs that roughly correspond to the deployment sequence summarized in the Introduction.

Table 4 – Planning

Table 4 summarizes information from several studies about training needs to address the ITS planning function. Planning for ITS has several facets. Some are oriented to design and construction, others to integrating the ITS planning process into the larger transportation planning process. Note that this table differs from the other tables in this section. Planning serves as both the table title and as the general ITS skill. What follows are specific skills within the planning category.

Level of Interest	Planning	Planning	Design	Construction	Operations	Maintenance	Management
H	Contracts and Procurement						
H	Institutional Issues	X			X		X
H	Planning (Process for ITS)						
M	Benefits/Costs	X			X		X
M	Costs and staffing requirements					X	X
M	Demand Management Strategies						
M	Evaluation						
M	Integration of ITS into the planning process	X					
M	ITS Benefits	X					X
M	ITS costs		X				
M	ITS Deployment Planning	X			X		X
M	Partnering						
M	Research & Development						
L	International Issues						
L	ITS Overall/Integrated Planning						
L	Needs Determination						
L	Risk Management						

Table 4 - Planning

Table 5 - Design & Construction

Table 5 combines information from several reports about training needed for the ITS design and construction functions. Several reports noted that, while individuals with these skills are available, they do not generally work in the transportation field. One of the challenges that needs to be addressed for full deployment of ITS is how attract people with this skills to transportation organizations and how to train transportation professionals in these skills. This has been characterized as training traffic engineers in systems engineering and systems engineers in traffic engineering.

Level of Interest	Design & Construction	Planning	Design	Construction	Operations	Maintenance	Management
	Construction						
M	Acceptance/Inspection			X			X
M	Construction/Inspection/Practices						
	Design						
H	Systems Architecture						
M	Integrating ITS into facility design		X				
M	Plan reviews and specification development		X				
M	Specifications						
M	Standards						
M	Systems Engineering						
L	Systems Design						
L	Systems Integration						
	Other						
L	Electrical Engineering						
L	Human Factors						

Table 5 - Design & Construction

Table 6 - Onerations & Management

Table 6, the final table, summarizes information from several reports identifying Operation and Management training needs. The effectiveness of ITS will be demonstrated by how well the system works. This will create unique demands on managers at all levels and will require staff with specialized operational skills. Reports also note that managers and operators will need considerable flexibility to address the range of responsibilities required for ITS deployment. Several studies recommend cross-training staff at the operations and management level to address this need.

Level of Interest	Operations & Management	Planning	Design	Construction	Operations	Maintenance	Management
	Operations & Maintenance						
H	Operations & Maintenance						
M	Operations & Maintenance Costs					X	
NR	Managing ITS projects						
NR	Inspection procedures for ITS equipment						
	Traffic Engineering						
M	Traffic Flow Theory						
L	Traffic Engineering						
	Training						
M	Technical training				X		
M	Technician training				X		
M	Train the Trainer/How to Train						
L	Operator Training						

Table 6 - Operations & Management

D. Other Issues

Identifying training needs cannot be limited to specific skills where training is required but must consider other issues, including how training is delivered and institutional barriers to training. A concern identified in many of the reports is that sufficient resources will not be available for future training efforts. One report notes that training is a low priority in many organizations. This report likens securing resources for training to the difficulty transportation agencies have securing sufficient resources to operate and maintain existing infrastructure. These issues fall into two broad categories, training delivery and institutional barriers to staffing and training.

While agencies are aware of several sources of training, they are not aware of all sources. The preferred providers and methods of training are those that have historically been used by the transportation profession. These include National Highway Institute (NHI) and National Transit

Institute (NTI) courses, colleges, conferences/workshops, seminars, and equipment vendors courses. Time and budget concerns are identified as a barrier to training, one which can be somewhat addressed by providing training through one-day seminars, short courses, in-house training, videos, simulations, and table-top exercises.

ITS deployment will require attracting people from outside traditional transportation disciplines into the transportation sector. One study found that the major problem in meeting staffing requirements will be in economic, social, and environmental areas and operation and maintenance, not in technical areas. Institutional issues affecting staffing in training are usually outside of the control of agencies involved in ITS. State and local governments, for example, either have specific policies designed to reduce total staffmg or regularly address budget issues through freezes on hiring staff or contracting work. In addition, many transportation organizations only have career tracks for civil and traffic engineers, but not for other professionals.

In summary, other major issues are:

- Training will require dedication of long-term resources.
- Delivery mechanisms should be targeted to address needs of organizations requiring training.
- Staffing must address institutional issues as well as training issues.

III. Knowledge Gaps

The studies done to date provide a starting point for identifying ITS skills, training needs, delivery methods, and training sources. They also provide some insights into the training and staffing concerns of organizations that will deploy ITS. This information provides a solid starting point for a comprehensive analysis of ITS staffing and training needs across the deployment sequence and through organizations and responsibilities. That analysis will then provide a basis to evaluate existing training, develop new courses and curricula, and create a standard by which future training needs can be assessed.

The previous chapter offered a synthesis of what was learned from the thirteen studies conducted to date and identified issues raised from this review. The analysis of these studies revealed gaps in the existing foundation of knowledge about building professional ITS capacity. Specifically, gaps exist in the following areas:

- State of the knowledge about core knowledge, skills, and abilities required for ITS deployment and operation.
- State of specificity for developing curricula, courses, and programs for ITS training, education, and outreach activities.
- State of the knowledge of course delivery and delivery mechanisms.

Most of the studies surveyed only the first issue, and often in general terms. For example, it is not unusual to see computer training identified as a need created by ITS. Studies provide no additional information to determine whether this training is required due to an overall lack of computer expertise in an organization or due to some specific aspect of ITS that will require specific types of computer skills. This lack of specificity makes development of training difficult.

Several studies identify specific training needs and approaches to training for ITS. Synthesizing the information from these studies results in identifying some skills and functions requiring ITS training. What is more important, it results in identifying what we do not know, or isn't known in sufficient detail, about ITS staffing and training needs.

The Urban Institute Study identifies some skills required for ITS deployment. Studies done by the FHWA and the I-95 Coalition add to this list of skills. The I-95 Coalition study goes a step further by relating skills to ITS functions as well as identifying training currently available.

A comprehensive needs assessment will take this work a step further by linking skills to deployment stages and training needs. Such an assessment will also evaluate available training against the needs to identify courses and provide a foundation for creating curricula, courses, and training for specific skills. A comprehensive assessment would also identify how to deliver and evaluate training. The next part of this chapter describes a framework for identifying core knowledge, skills and abilities, which provides a starting point for a comprehensive needs assessment.

A. Identifying Core Knowledge Skills and Abilities

The first step in relating skills and training needs to the deployment is to identify the deployment sequence. While ITS is rarely deployed in a linear fashion, identification of a deployment sequence allows for a targeted identification of knowledge, skills, and abilities needed at specific times. Organizations and job categories can then be attached to this sequence to identify who needs these skills when. In general, the ITS deployment sequence includes:

- **General Awareness** of ITS that establishes the foundation for understanding the need for ITS, the scope of ITS, and the roles of the agencies involved in ITS deployment;
- **Planning for ITS** which encompasses the notion of establishing a regional framework and develops an understanding of conformance to the National Architecture;
- **Designing for ITS** with an eye towards interoperability and intermodalism;
- **Procuring for ITS** including innovative financing methods;
- **Installing ITS** which Includes the role of contracting organizations; and
- **Operating and Managing the** ITS system once deployed.

The deployment sequence provides a structure for identifying core skills and associated training needs. Unfortunately, none of the studies completed to date have systematically related knowledge, skills, and abilities and training needs to ITS deployment. Most studies have started with either a

general understanding that ITS will require some technical skills, such as computers or communications. Other studies took a known component of ITS, such as a Traffic Control Center, and considered the training needs to operate and maintain that center.

Some skills are needed across the ITS deployment sequence, while others are specific to a deployment stage. A comprehensive needs assessment would identify the training needs for skills required at each stage of deployment.

Most of the studies reviewed considered whether enough is known about ITS to identify future skills required and training needs. A few studies looked at specific types of jobs, such as those in a traffic control center, to better understand the skills required to do what is currently being done. This then becomes a starting point for more discussion of how something being done today will change because of increased attention and resources going toward ITS. The result of these studies is less a detailed understanding of skills for ITS than a discussion of the skills and training needed to accomplish specific tasks in specific organizations.

In summary, identifying core knowledge, skills and abilities requires:

- Using the deployment sequence to structure this analysis.
- Evaluating knowledge, skills and abilities needed at each stage of the deployment sequence.
- Identifying future skills that will be required for ITS deployment and operation.

B. Developing Curricula, Courses, and Training

Most studies do not provide enough specificity to develop comprehensive courses and outreach materials. Developing this training requires understanding overlaps and linkages between job categories with ITS responsibilities throughout various agencies. Training needs also must be ranked to ensure that development of training meets the need for training. A starting point for developing curricula, courses, and training is existing training in areas related to ITS, but analysis of this training must be critical.

Specificity is important when developing a training program to ensure that the training addresses staffing needs. This begins by getting a better understanding of skills needed for ITS deployment. Many studies identify these needs so broadly that meaningful training cannot be developed. For example, developing training based on an identified need for people with computer skills is quite difficult when little additional information is available about what kind of computer skills are needed.

Understanding overlaps and linkages is necessary because many ITS technologies are applicable to multiple modes of surface transportation and across geographic areas. This provides the opportunity to develop courses that cover information useful to many agencies and ITS functions. Recognizing

these linkages and overlaps can help in providing training that is intermodal and integrated. It also allows for efficient use of limited training resources.

Training needs will change over time, which requires establishing priorities for **training** based on current and future needs. Some studies attempt to rank training needs, but it has been done in a very general way driven by a current need of a specific organization. Developing a national program requires looking across all stages of ITS deployment and implementation of ITS and identifying present and future training needs.

Several studies looked at available courses to address ITS training needs. This analysis was, for the most part, superficial. For example, one study recognized a need for training in Advanced Vehicle Identification (AVI)/Advanced Vehicle Location (AVL) and identified a course for this training. The course, however, does not provide the training needed for ITS. A close examination of the course found that the course is an overview of vehicle positioning and navigation for land, marine, and air systems. It also does not address AVI/AVL highway and transit operations at level of depth that would be useful to operators of such a system.

The proceedings from the ITS Education and Training; Strategic Planning Workshop report that the most people need general training. Specialized training should include a broad spectrum of participants in the transportation research, education, planning, construction, operation, maintenance, management, and policy making process. Other studies support this conclusion.

Most of the studies assume that transportation personnel will be trained in aspects of ITS, including those necessary for the operation of ITS but not specifically transportation skills. Training people with skills such as communications and computers to understand basic transportation issues and issues related to ITS also will be necessary. This is important to note because the Urban Institute found that sufficient staffing for ITS requires attracting people from outside the transportation profession for ITS work.

In sumamry, development of courses, curricula, and training requires:

- Ranking training needs.
- Evaluating exisiting training in ITS related skills.
- Having the flexibility to address changes in ITS training needs.

C. Delivering Training

Various and disparate ITS courses and training programs are in existence. These programs often treat ITS as an exotic afterthought rather than as an integral part of the surface transportation system. Any training program must also address practical obstacles to learning, be well publicized, and include a mechanism for evaluating the effectiveness of various training approaches.

Some studies identify courses that may address some ITS training needs. The largest compilation is reported in the I-9.5 Coalition study. A review of these courses found that, for the most part, the courses were developed to address a specific need at a specific location. For example, one state conducted a skills assessment and recognized a need for training operators in advanced traffic signal control systems. The impetus for this effort was an economic development initiative. In other efforts, professional associations and the federal government have developed courses on various aspects of ITS implementation and some universities are developing ITS courses as part of their graduate transportation engineering programs.

Some ITS courses are autonomous seminars that address specific issues related to ITS without putting ITS into the larger context of an integrated transportation system. Training programs that treat ITS as an afterthought or as an exotic approach to addressing transportation issues. This approach is not compatible with the goal of fully integrating ITS into an intermodal and multimodal transportation system.

In sumamry, delivering training requires:

- Assessing how training will be delivered is as important as developing courses and curricula.
- There are constraints to receiving training, including time, costs, and distance.
- Training delivery methods which can address constraints, including development of training videos and provision of on-site training.

IV. A Framework for a Comprehensive ITS Needs Assessment

The major ITS training issues described at the beginning of this report highlight the need for a thorough and comprehensive assessment of ITS training needs. The studies done to date provide an important foundation on which to build a method for assessing training needs. However, they do not provide sufficient information to develop a comprehensive approach to ITS training.

The first step in a comprehensive needs assessment is to work withing the ITS deployment sequence and identify the training required at each stage. The deployment sequence has been identified. The next step will be to is identify skills and training needs at each of these stages. The deployment sequence presented in Section III begins this process. The second step in developing a comprehensive needs assessment will be to identify training needs at the executive, management, practitioner, and technician levels of organizations that will be involved in ITS deployment. A valuable source of information will be individuals currently involved at some level of ITS deployment, which could range from planning to full scale operation.

Information gathered in this second step would include how individual jobs/functions relate to ITS, how personnel holding those positions obtained skills, and identification of other skills needed to do the job. Other information that would be collected from practitioners would be identification of skills that are most critical and immediate, changes needed in the job/function to support ITS

deployment, and anticipated future training. The positions themselves would be identified along the ITS deployment stage sequence to identify where and when skills are needed.

The I-95 Corridor Coalition Final Report may be a model for a comprehensive assessment of ITS training needs. This study provides a good understanding of skills required and training needs for those staff with ITS-related responsibilities along that corridor. It also identifies the most comprehensive catalog of ITS-related training currently available. The study did not look at ITS training needs through all of the organizations potentially involved with ITS along the I-95 corridor, nor does it look across each organization to assess training needs.

Given limited resources to analyze training needs and to develop training, the development of a comprehensive needs assessment will require setting priorities. ITS is being implemented at various levels of intensity in different parts of the country. Areas are also at different stages in the ITS deployment sequence. Where areas are now, in both level of intensity and stage in the deployment sequence, provide a starting point for collecting information on staffing and training needs across organizations, at different levels within organizations, and across the deployment sequence.

Collecting information at selected areas at various stages of ITS deployment will provide an objective understanding of who is involved in ITS, what skills they bring to their jobs, and what skills are needed to continue to support their work. Collecting this information from areas at different stages of ITS deployment would provide some insight into the skills needed along the deployment stage sequence. This also will help in setting priorities for development and delivery of training. Given that the studies done to date do not provide a comprehensive assessment of ITS training needs, and given the priority ITS has been given on both a national and local level, it is important that this comprehensive assessment gets done.

V. Summary and Conclusion

This analysis and summary of thirteen studies provides a starting point for a comprehensive assessment of ITS staffing and training needs. Information from the studies reviewed for this report provides some useful information for developing some ITS courses and curricula. The Field Interview Report will provide additional information for this work.

The thirteen studies provide some information on current ITS staffing and training needs and some sources of training. These studies also identify issues related to the delivery and support of training within institutions deploying, or considering deploying ITS. The studies also identify gaps in knowledge. A major gap is identifying what skills are needed across the ITS deployment sequence and at all levels of responsibility within organizations responsible for ITS deployment. This information provides the basis for the next steps toward a comprehensive assessment of ITS staffing and training needs, which will define the professional capacity building program over the next five years.

The next steps include a systematic ranking of training priorities, identification of skills and training needs to organizational levels, and gathering information to fill identified knowledge gaps. A comprehensive assessment of ITS staffing and training needs will address these key needs. This assessment will lead to:

- understanding the full scope of ITS knowledge, skills, and abilities;
- understanding skills needed at each point in the ITS deployment sequence; and,
- understanding skills required by ITS organizations at each organizational level.

This information can then be synthesized to identify staffing and training needs. This synthesis becomes the basis for evaluating existing training courses and developing new courses and curricula. This will result in the provision of training and the development of the skilled workforce needed for full ITS deployment.

Appendix A - Staffing Studies

Report/Paper: Institute of Transportation Engineers (ITE). *white Papers: Operating and Maintaining Advance Traffic Management Systems (ATMS) Centers, Preparedfor the National Conference on Operating and Maintaining ATMS Centers,* September 14 and 15, 1996, Minneapolis, MN.

Method: Review of literature.
White papers on specific aspects of operating and maintaining ATMS Centers.
Workshop discussions.

Key Finding(s): Cross train staff within organization and through visits to other centers.
Training should be on-going process.
Supplement classroom training with simulated events or table top exercises.

Training Needs: Refer to training needs identified in I-95 Study, including Communications and computers, specifically related to O&M of new systems like Advanced Vehicle Location (AVL), Computer Aided Dispatch (CAD), and Automated Traffic Counting Systems (ATCS), and systems engineering.

Other Issues: Increased use of ATMS elements expected.
Minimum operation and maintenance standards essential to improving agency O&M abilities.
Improved O&M of Freeway ATMS (FATMS) will require additional resources including funding, staff, and training.
ISTEA will increase FATMS activities.

Conclusion: Review of literature and identification of issues related to training staff to operate and maintain traffic management systems centers. Two white papers, one on staffing, one on training, identify significant concerns about availability of training and staff for these centers.

Report/Paper: Kraft, Walter H. *Conference Summary and Conclusions, ITE National Conference on Operating and Maintaining ATMS Centers*, Minneapolis, MN; September 14 & 15, 1996.

Method: Synthesis of information collected at Minneapolis, MN workshop.

Key Finding(s): Made recommendation regarding administration, operation, funding, staffing, National Transportation Information Communications Protocol (NTCIP) standards, training, liability, and computer systems issues related to Transportation Management Centers. The key recommendation regarding staffing and training is that sufficient qualified, well-trained and cross-trained staff need to be provided to both operate TMC systems and maintain TMC software/hardware.

Training Needs: Training recommendations include:

Cross-training within agencies,
Including training requirements on operating and maintaining technology in contract specifications,
Training coordinators should develop and update training matrices for agency classifications,
Visits to other TMCs should be part of training,
Training should be provided to staff outside of the TMC to provide additional staff when needed,
Training should include simulations and table top exercises,
Use of expert resources from other industries,
Establish and maintain database of operation and maintenance contacts and training programs,
ITE should work with educational institutions to develop and update curricula to reflect training needs of TMC staff.
Agencies should identify a training coordinator, and
Agencies operating TMC should work with stakeholder organizations to include applicable training in their programs.

Other Issues: Identify staffing, funding, operational, and other issues related to all aspects of operating a TMC.

Conclusion: Summarizes information gathered at workshop on operating and maintaining Advanced Traffic Management Systems (ATMS). Identifies priorities of traffic engineers with responsibilities related to ATMS. Focus is on needs of traffic engineering staff involved with TMCs.

Report/Paper: McComb, Dwight E. and Martin *3.* Monahan. *Federal Highway Administration ITS Field Technical Expertise; Workshop Summary Report,* Chicago, IL, December, 1994.

Method: Information collected at workshop of FHWA personnel. Draft version reviewed by FHWA staff and comments incorporated into this report.

Key Finding(s): Technical expertise is important in the ITS program. The FHWA has a major role in providing technical expertise. The workshop identified 80 specific needs to enhance FHWA field staff stewardship of ITS program. These fall into three types of technical expertise: Program and project management; Basic technical concepts and application; and Detailed design.

Training Needs: Gain and maintain better working knowledge of technical issues through a database that addresses technical transfer issues, courses and workshops on core technical issues, development and dissemination of state of the art product and project information, and identify critical items from use in staff analysis of ITS projects.

Other Issues: FHWA should also provide access to high level technical expertise, develop guidelines for PS&E reviews and field inspections, contract support, develop an in-house inventory of technical expertise, and support enhancement of State DOT technical expertise.

Conclusion: Identifies **roles** and responsibilities and prioritizes the technical expertise needed by of FHWA staff who have ITS responsibilities.

Report/Paper: Robinson, Carlton *C. Traffic Operations Manpower; (A Scoping Study of Education Needs and Responses,* Prepared for the National Highway Institute, FHWA, October 15,1994.

Method: Interviews with professional leaders and review of literature and programs. Two day meeting with 12 senior level professionals representing employers of entry-level traffic operations personnel. Meeting with professionals representing transportation and educational organizations.

Key Finding(s): Public agencies that hire individuals in the professional traffic operation field requires 550 new entrants annually. Emerging needs of ITS may create a need for an additional 300-500 annual entrants.

Training Needs: Recommend a core curricula for professional entrants in the traffic operations field.

Other Issues: Program outlined, while not equivalent to a masters degree program, would equip entry level candidates for traffic operations jobs with the base of knowledge needed to undertake entry level duties.

Conclusion: Study identifies knowledge areas required of traffic operations professionals serving state and local government. Begins to define a modular education and training program to build knowledge areas for potential candidates to do this work. This was designed to establish priorities for the NHI and others involved in training.

Report/Paper: Urban Institute, *IVHS Staffing and Education Needs,* Prepared for the US DOT, Federal Highway Administration (FHWA), September, 1993.

Method: Purposes of study was to identify labor market availability of staff for full deployment of IVHS. Used data from several sources as input to model which projected both demand for and supply of IVHS labor. Conducted interviews and surveys of potential employers of IVHS staff.

Key Finding(s): Labor market can meet demand for trained technical staff, but only if opportunities provided for skilled professionals from fields that are reducing employment opportunities. Specifically identify the defense industry as a source of staff with required technical skills.

Training Needs: Retraining of professional and technical personnel within and outside of the transportation field.
Need for training to develop leadership, facilitator, coordination, political, and program management skills.
Multi-disciplinary training required, including electronics, telecommunications, traffic engineering, human factors, and software engineering.
Specific training needed to increase personnel with skills in maintenance and operation of traffic signal systems, deploy, operate, and maintain automated traffic controls, and develop and manage databases.
All aspects of implementing ITS in rural areas.

Other Issues: Problems meeting staffing requirements will not be in technical areas but in economic, social, and environmental areas and operation and maintenance.
Wage caps, hiring ceilings and other institutional constraints will cause bottlenecks in staffing.
Training method will differ with skills being taught and audience receiving training.

Conclusion: Analysis of the labor market to determine whether adequate staff will be available for full implementation of ITS.

Appendix B - Training Studies

Report/Paper: California Advanced Transportation Training Alliance. *The View Ahead,* Prepared for the Project California Select Panel Meeting, March 22, 1996 (Revised).

Method: Cite Project California report identifying application of advanced technology to transportation issues as a promising area for economic development. Interviewed firms involved in advanced transportation industry, found that these firms have had problems obtaining qualified employees.

Key Finding(s): Identified four occupations requiring immediate training, these are:

Project manager/traffic systems
Automatic traffic signal system technicians
Electric vehicle mechanic (not ITS)
Geographic information system specialist.

Training Needed: Subjects related to above occupations.

Other Issues: Need to develop organization to identify and analyze occupations in advanced transportation industry, analyze technology, industry structure, and location, pinpoint training needs, develop curriculum to meet demand for new skills and arrange for training.

Conclusion: Funding proposal. Plan to do needs assessment once funding secured.

Report/Paper: Institute of Transportation Engineers (ITE). *Urban Traffic Engineering Issues and Answers: Urban Traffic Engineering Education and Training Needs, Final Report,* Undated.

Method:
Literature review
Surveyed traffic engineering agencies.
Focus group meetings.
Project committee discussions.

Key Finding(s):
Traffic engineering staff training areas include both technical and non-technical subjects.
Graduates prepared in traditional civil engineering areas, but not in traffic or non-technical areas.
Need for continuous education.
On-the-job, on-site and remote training most effective.
Time and budget constrain training.
Agencies use short courses for traditional traffic engineering subjects, also require training in new subjects like ITS and TDM.
Lack of awareness about training resources.

Training Needed:
Non-technical subjects like technical writing, communications, and administration.
Awareness of ITS and other advanced traffic insuring subjects/
Traffic Demand Management (TDM).
Implementation, operation, and maintenance of traffic control systems including, but not limited to, ITS.

Other Issues:
Develop core curriculum from the proposed Traffic Operation Core Curriculum, require that courses funded through NHI grants be patterned after this curriculum.
Develop media for education and training in traffic engineering.
Implement traffic engineering certification program.
Support of Technology Transfer Centers and Urban Transportation Centers and coordinate activities with these organizations and professional and industry organizations.
Increase awareness of existing resources.
Sensitivity to cost, time, and location issues when developing training.

Conclusion:
Report on training and staffmg needs associated with traffic engineering. Focus narrower than ITS but is specific to an ITS function.

Report/Paper: ITS America and US DOT, FHWA. *ITS Education and Training; Strategic Planning Workshop Proceedings,* Sheraton Reston Hotel, Reston, VA, June 12-14, 1995.

Method: Presentations designed as starting point for workshop participants consideration of ITS education and training needs.
Discussion guidelines.
Workshop break-out sessions considered education and training demand and supply issues for different levels of training providers and specific types of organizations requiring training.

Key Finding(s): ITS staff need training in variety of technical and non-technical subjects.
Supply side sessions identify sources of training.
One page synthesis provided of demand and supply side sessions.

Training Needs: ITS providers, transportation decision makers, educators, students, and transportation users need education and training in ITS awareness, technology, economics, and institutions.
Specific knowledge is required in:

- Computer Science.
- Economics.
- Human Factors.
- Communication technologies.
- Information systems.
- Systems analysis/engineering.
- Government structure and institutional arrangements.
- Finance, procurement, and developing partnerships.

Other Issues: ITS training needs should be addressed as early as elementary school.
Formal programs for ITS staffing should begin in Junior College.
Existing sources of training should be used to deliver training.
Different responsibilities require different knowledge at each stage of the deployment process.

Conclusion: Papers presented to workshop participants and reports from workshops that considered ITS training from both the demand and supply sides. Participants in workshops included academics, state and federal officials, consultants and industry representatives, and students.

Report/Paper: ITS America and US DOT, FHWA. *Strategic Plan for ITS Education and Training (Draft),* Developed from the ITS Education and Training Workshop, June 12-14, 1995, Reston, VA, July, 1996.

Method: Draft summary of Reston workshop proceedings.

Key Finding(s): Workshop identified three essential components required to successfully implement ITS initiatives, they are; awareness, education, and training.

Training Needs:
Awareness
ITS Technologies
Partnerships
Systems engineering
Procurement
ITS costs and benefits

Other Issues:
Increase staff and financial resources to support ITS-related student activities.
Develop and disseminate educational materials.
Help colleges and universities identify funding for curriculum development and other educational activities.
Investigate development of ITS Education and Training Institute.
Enhance knowledge of FHWA and FTA field staff.
Identify the feasibility of creating an ITS America Education and Training Excellence Award.

Conclusion: Restates major issues identified in workshop proceedings. Focus narrowed.

Report/Paper: United States Department of Transportation (US DOT), Office of Traffic Management and ITS Training Team. *DOT ITS Professional Capacity Building Assessment*, May 24, 1995.

Method: In house assessment by task force of US DOT staff to develop a federal perspective and plan for addressing ITS education and capacity building issues. Categorized training into three types; awareness, overview, and skills and knowledge training. Identified personnel requiring each category of training including DOT staff, other federal staff, elected officials, state and local staff, academics and students, the private transportation sector (consultants, operators), and ITS users (drivers, transit riders, etc.).

Key Finding(s): All transportation personnel require awareness training.
Federal, state, and local technical personnel should be provided overview training.
Skills and knowledge training should be provided for entry level through long term specialists that cover all aspects of the ITS program.
ITS skills for FHWA technical specialists should be developed.

Training Needs: Development of an intensive post-graduate traffic operations/ management certificate program.
Develop and offer new workshops, seminars, and short courses on narrowly focused ITS Technical topics.
Task Force divided into five groups, each group identified training needs. The groups collectively identified 54 specific training needs. Some identified more than once. (See List)

Other Issues: Identify a number of methods to deliver training. Identify existing training providers. Identify need to identify and prioritize staff requiring training. Need to develop a strategy to show importance of ITS staff training to senior management and elected officials.

Conclusion: Listing of training needs and training approaches fist step in setting priorities, identifying who needs training, and developing courses and curricula.

The following information is from the report summarized on the previous page. Five groups of FHWA staff were asked to identify ITS training needs. Each group reported training needs and the number of groups identifying the same need are provided below.

ITS Training Need Identified by

Five of Five Groups
Operations & Maintenance
Planning (Process for ITS)

Four of Five Groups
Communications
Contracts and Procurement
Marketing/Market Evaluation
Overview
Systems Architecture

Three of Five Groups
Awareness
Computer Systems/ADP/Software/Hardware
Construction/Inspection/Practices
Funding/Financing
Institutional Issues
Legal Issues
Standards
Systems Engineering
Traffic Modeling Software
User Services

Two of Five Groups
Benefits/Costs
Demand Management Strategies
Design Features
Evaluation
Incident Management
Partnering
Research & Development
Safety
Specifications
Traffic Control Systems
Traffic Flow Theory
Train the Trainer/How to Train

One of Five Groups
Acceptance Inspection
ATMS Control Center Operations
Computer Selection
Electronic Toll and Traffic Management (ETTM)
Electrical Engineering
Federal Aid Process
Human Factors
Information Dissemination Techniques
International Issues
ITS Overall/Integrated Training
ITS Technical Issues
ITS Technologies
Navigation
Needs Determination
Operator Training
Risk Management
Security
Signal Timing
Successes & Benefits for Congressional Staff
Systems Design
Systems Integration
Traffic Engineering
Traveler Information
User Acceptance

Appendix C - Staffing and Training Needs Assessments

Report/Paper: I-95 Corridor Coalition *Project I1 Training and Technology Exchange Final Report,* Prepared by I-95 Northeast Consultants, August, 1996.

Method: Synthesized information from other reports and studies.
Surveyed agencies involved in ITS deployment and providers of training to transportation professionals.

Key Finding(s): Identified the following six major functional areas were training will be required: Planning; Design; Construction/Installation; Operations; Maintenance; and Management.
Functional areas roughly conform with the deployment sequence.
Some training in ITS technologies identified.

Training Needs: Survey respondents identified extensive, moderate, or little or no training needs by each functional area. (See Table)
Training needs identified broadly by technologies, then narrowly within technologies. For example, Communications is further narrowed to include Wire, Wireless, Information Exchange Network, and National Transportation Information Communications Protocol (NTCIP).

Other Issues: Survey also asked questions about agency training programs, types of training preferred (hands-on, computer tutorials, etc.), training providers, and training program conditions (days, location, cost). Provide some guidance when designing delivery approach. Identifies training programs.

Conclusions: Assessment of training needs of agencies involved in implementing ITS along the I-95 Corridor. Most extensive analysis done to date. Limited to needs of agencies along single corridor developing specific approaches to traffic management. Training courses and curricula are not evaluated for appropriateness to training needs, more analysis of these programs required.

I-95 Study. Summary Table (Previous Page)

Technology	Planning				Design				Construction				Operations				Maintenance				Management			
	E	M	L	NR	E	M	L	NR	E	M	L	NR	E	M	L	NR	E	M	L	NR	E	M	L	NR
ATMS Traffic Control & Surveillance																								
- Probe Technologies		X				X				X			X	X				X				X	X	
- Sensor Technologies		X				X				X				X			X					X		
- CCTV		X				X				X			X				X					X		
- Freeway Control	X					X				X			X					X				X		
- Traffic Signal Control				X				X			X		X				X					X		X
- HOV Lane Control		X			X					X			X					X				X		
- Video Imaging Processing		X				X				X				X				X				X	X	
- Violation enforcement systems		X				X	X			X	X			X				X				X		
- Ramp metering			X				X				X		X					X				X		
- AVL/AVI		X					X				X		X				X					X		
Incident Management																								
- Incident detection & verification	X					X				X			X				X					X		
- Incident Response	X				X					X			X				X					X		
- System Optimal Routing	X					X				X			X					X				X		
Electronic Toll & Traffic Management				X				X				X				X				X				X
ATIS																								
- Broadcast-based		X		X	X	X	X	X				X	X	X			X					X		
- In-vehicle				X			X				X		X						X				X	
- Variable Message Signs (VMS)		X			X					X			X				X					X		
- Highway Advisory Radio (HAR)	X	X	X	X	X					X			X				X	X				X		
- Kiosks		X				X				X		X	X					X					X	
- Traveller advisory telephone		X				X					X			X				X	X				X	
- Route guidance	X	X		X		X					X			X				X				X		
APTS																								
- Transit vehicle tracking				X			X				X				X				X				X	
- Multi-modal coordination		X				X					X	X		X					X			X	X	
CVO																								
- Freight administration			X				X				X				X				X				X	
- Fleet administation			X				X				X				X				X				X	
- Electronic clearance				X	X	X	X	X				X	X	X				X					X	
- Weigh-in-motion	X					X	X			X	X			X				X					X	
- Roadside CVO safety				X		X				X				X				X					X	
- HAZMAT management		X					X				X	X	X				X		X		X		X	
Communications																								
- Wire	X					X			X					X			X					X		
- Wireless	X				X				X				X				X				X			
- IEN		X						X				X		X				X			X			
- NTCIP	X				X							X	X	X			X				X			
TMC	X							X				X				X				X				X
ITS Deployment Planning	X	X						X				X	X							X	X			
Institutional Issues	X	X						X				X	X							X	X	X		
Computer Systems																								
- Hardware		X				X				X				X			X					X	X	
- Software		X				X				X				X			X					X	X	

E = Extensive, M = Moderate, L = Low, NR = No Response

X indicates the most common response or responses in surveys conducted as part of the I-95 Coalition Training and Technology Exchange Final Report.

Report/Paper: *SAIC/JHK Technical Memorandum on ITS Training Needs*, Presented to the Office of Traffic Management and ITS Applications, US DOT, July, 1996.

Method: Reviewed studies done to date. Information from surveys used to develop a series of questions which were then used to gather information from 27 respondents. Respondents included six FHWA Region offices, six FHWA Division offices, four State DOT ITS contacts, four State DOT Training Coordinators, five transit agencies, and two MPOs.

Key Finding(s): Current levels of knowledge adequate to support current ITS activities.
Current knowledge does not exist to enhance the ITS programs.
On the job training and experience source of most knowledge of ITS.
Identified specific training needs by same functional categories identified in I-95 Study.

Training Needs: Summary include Hardware/Software operation and maintenance, quantifying benefits, integrating ITS into the planning process.
(See Table)

Other Issues: Agencies are aware of several sources of training, including NHI, colleges, conferences/workshops, seminars, and vendors courses. Most favored means to accomplish training are seminars, short courses, in-house training, and videos.
Lack of funds for travel and training and lack of time cites as obstacles to training.
Most favored course length is 2/3 of a day. Other responses, which depended on training topic, were one day and 4/5 of a day.

Conclusion: Outlines information from various reports on ITS training needs. Initial attempt to synthesize training studies done to date.

Summary of Information from the SAIC/JHK Technical Memorandum (Previous Page)

Training Area	Functional Area					
	Planning	Design	Construction	Operations	Maintenance	Management
General Overview of ITS	X					
ITS Benefits	X					X
Integration of ITS into the planning process	X					
Technologies for different levels of personnel	X	X	X	X	X	X
Integrating ITS into facility design		X				
Plan reviews and specification development		X				
Procurement issues		X				
ITS costs		X				
Inspection procedures of ITS equipment			X			
Technician training				X		
Operations and maintenance costs					X	
Technical training			X			
Costs and staffing requirements					X	X
Managing ITS projects						X
Systems engineering						X

An X indicates a need for training in the specific functional area for the training area. For example, General Overview of ITS Training is needed the Planning Functional Area. ITS Benefits training is needed for the Planning and Management Functional Areas.

Note that this study is not a needs assessment but a model for completing a needs assessment.

Report/Paper: Virginia Tech. *Virginia Tech Model for Professional Capacity Building: Comprehensive Needs Analysis & Functional Specialization*, Undated.

Method: Begin with 405 potential training areas for PCB. Next step is to determine who will be the beneficiaries of PCB efforts. For example, what skills are required for staff responsible for an Incident Management System?

Key Finding(s): Identify 405 potential training/education targets by considering three-dimensional matrix that includes 9 Functional areas, 9 ITS components, and 5 types of organizations requiring training.

Training Needs: Functional areas where training is required for ITS components are Planning, Funding/Policy, Design, Construction/Inspections, Operations, Maintenance, Major Investment Studies (MIS), Enforcement, and Public Relations.
ITS Components include Freeway Management Systems, Traffic Signal Systems, Incident Management System, Traveler Information System, Transit Management System, Electronic Toll Collection, Electronic Fare System, Railroad Grade Crossing, and Emergency Response Providers.
Sectors requiring training are Federal Agencies, State Agencies, Local Agencies, Private Corporations, and Educational Institutions.

Other Issues: Need to determine what organizations will be responsible for deploying ITS in order to determine who needs what training. The next step is to determine the level and type of training they need. Once training needs are established, it is possible to analyze existing resources that may be used to develop training courses. The last step is to identify the specific knowledge staff and students involved in ITS require.

Conclusion: Defines approach to identify ITS training needs, developing curricula, courses, and materials, and testing the effectiveness of materials.

Appendix D - Glossary of Acronyms

APTS	Advanced Public Transportation Systems
ATCS	Advanced Traffic Control Systems
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management Systems
AVI	Automatic Vehicle Identification
AVL	Automatic Vehicle Location
CCTV	Closed Circuit Television
CVO	Commercial Vehicle Operations
CAD	Computer Aided Dispatch
ETTM	Electronic Toll and Traffic Management
FATMS	Freeway Advanced Traffic Management Systems
FHWA	Federal Highway Administration
HAR	Highway Advisory Radio
HAZMAT	Hazardous Materials
IEN	Information Exchange Network
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
IVHS	Intelligent Vehicle Highway Systems
MIS	Major Investment Studies
NHI	National Highway Institute
NTCIP	National Transportation Communications Information Protocol
NTI	National Transit Institute
TDM	Traffic Demand Management
TMC	Traffic Management Center
USDOT	United States Department of Transportation
VMS	VariabIe Message Signs